

REMARKS

Reconsideration of the Office Action dated August 25, 2003 is respectfully requested.

The applicants would like to thank the examiner for his indication that to be made of record all art cited in the application must be submitted as required by MPEP § 609A. In accordance with this suggestion, an Information Disclosure Statement with appropriate fee has been submitted concurrently with this paper.

Claims 1 though 19 have also been objected to because of an inconsistency between the phrase "energy sensitive material" found in claims 1, 4, 7, and 19 as compared to the phrase "energy sensitive resist material" found in claims 2, 3, 8, and 15. Again the applicant would like to thank the examiner for his careful consideration of the application. Claims 2, 3, 8, and 15 have been amended to remove this inconsistency by deletion of the word "resist" from the latter phrase. This amendment has not been submitted in any way to overcome a rejection under 35 USC § 112 or an art rejection either under 35 USC § 102 and/or 103. The sole purpose for this amendment is to overcome the objection propounded by the examiner in his action.

The rejection of claims 1 through 19 under 35 USC § 112 second paragraph is respectfully traversed. The examiner has indicated that the phrase "the first pattern" lacks antecedent basis. It is the applicant's understanding of the examiner's rejection that this lack of antecedent basis makes it unclear whether the intent is to refer to the image of a pattern introduced into the energy sensitive material or to a different pattern.

Claim 1 in line 2 requires the introduction of a latent image pattern into an energy sensitive material. Line 4 of claim 1 then requires developing this image to form the first pattern. The first pattern has no antecedent

basis since it is the first time this phrase has been used. As discussed in the specification on page 3 lines 1 through 9 a latent image is introduced into the energy sensitive material and then developed into an actual pattern denominated the "first pattern" in the claims. Thus the first pattern and the "image of a pattern" are different items – the first being a latent image and the second being the developed pattern in the resist material that is no longer latent. Additionally, claim 1 in line 4 specifically requires that the first pattern have features, non-latent structures, in the energy sensitive material. Thus it is respectfully submitted that antecedency is not required and the meaning of the claims is that interpretation upon which the examiner based his search and art rejections. It is therefore respectfully requested that the rejection under 35 USC § 112 be withdrawn.

Claims 1 through 3, 9 through 13, and 15 through 17 have been rejected under 35 USC § 103(a) as unpatentable over US patent 5747196 (Chao) in view of US patent 5688634 (Mixon). This rejection is respectfully traversed. It is the applicant's understanding of the examiner's rejection that Chao teaches fabrication of a phase shift mask by forming a pattern resist layer through development and, subsequent to development, reducing the size of the developed pattern by isotropic etching. As indicated by the examiner Chao does not teach the use of a liquid isotropic etchant and thus Mixon is cited for this feature.

The applicants would like to emphasize that the invention involves 1) the introduction of a latent image into an energy sensitive material, 2) the development of this latent image into features in the resist material, 3) reducing the size of at least some of these developed features, and then 4) transferring the reduced features having a second size into the underlying substrate. The transfer of the reduced image must be done accurately or the invention objective – accurately reducing critical feature size from that obtained with the lithography employed – is not achieved. The attainment of

this objective with a liquid etchant is all the more surprising because such etchant is generally associated in the art with producing less precise features.

In contrast, as indicated by the examiner, Chao does not teach use of liquid isotropic etchants. This deficiency is significant because of the surprisingly good transfer accuracy achieved by the applicant using liquid isotropic etchant and the backdrop of conventional wisdom in the art. However, in the full context of Chao's objective to produce some critical and some non-critical features in a phase mask, this deficiency is even further amplified. Chao transfers the developed resist pattern using anisotropic etching before resist feature reduction to the critical feature of the mask. As shown in Fig. 5A of Chao, the critical feature is first transferred by anisotropic etching to the transparent material 33 and then after size reduction the narrowed resist line is transferred to a less critical feature 32 in Fig. 5C.

Figure 4A demonstrates that the transparent region produced by anisotropic etching has the critical dimension that must be controlled precisely while the dimensions of the opaque region produced after resist line reduction is used solely to define a region leading to compensating diffracted light. In particular the mask with opaque feature 22 and critical transparent feature 23, in use, is illuminated and the features of this mask are transferred into an underlying resist material. Although the amplitude of the light traversing the mask is shown in Fig. 4B because of destructive interference, the actual feature transferred is shown in Fig. 4C. Thus the feature size produced is not that defined by material 22 but is defined by underlying transparent material 23. The critical feature size of this underlying material 23 was produced by employing anisotropic etching of the transport material with the developed resist before the feature size of the resist is reduced. This is not to argue that a feature wasn't transferred by Chao after resist line reduction, but to emphasize that the objective of Chao

was substantially different from the subject invention and that this difference precludes combination of Chao with Mixon.

The applicants (in contrast to Chao) reduce the feature size of the resist using a liquid isotropic etching to produce a smaller critical feature size than that producible by the lithography employed. In one aspect of the invention despite the use of liquid isotropic etching the feature size is precisely controlled so that the transfer pattern has features of the size corresponding to the reduced resist features. In complete contrast in Chao, the precisely controlled features are those defined by anisotropic etching before resist line narrowing and not those defined by resist feature reduction using isotropic etching followed by pattern transfer.

This difference is extremely significant in viewing the teaching of Mixon and its combination with Chao. Mixon also, although disclosing the use of an isotropic etchant, does not disclose the use of that etchant to reduce feature size or even to treat the resist material after the features are produced in the resist through development. As noted by the examiner, Mixon employs a cyclical process to develop a resist material having a latent image. The entire development process through all its cycles is performed to produce the features in the resist. No treatment of the resist with a liquid isotropic etchant occurs subsequent to the production of the resist features through this cyclical development process. The features produced by the liquid etchant are those corresponding in size to the latent image. Indeed Mixon cautions, as noted by the examiner, that the use of the cyclic process has the attribute of not reducing resist thickness and thus certainly not reducing feature size. (An isotropic etchant is one that removes material at the same rate vertically (thickness) as laterally (line width).)

Neither Chao nor Mixon disclose the use of a liquid isotropic etchant after development. Chao uses the line reduction not to achieve a feature size

of more demanding dimension than that achievable with the employed lithography, but as an expedient to produce a coarser feature. This fact coupled with the general use of isotropic etchant in less demanding applications demonstrates that the Mixon and Chao should not be combined. Finally, McKee (cited by the examiner) teaches use of plasma etching for resist line reduction after development. If McKee is to be considered a person of at least ordinary skill, he certainly did not recognize the advantage of using a liquid isotropic etchant, indeed, McKee uses a plasma etchant. Thus McKee further emphasizes that such a combination of Mixon with Chao would not be made by a person of ordinary skill.

Claims 4 through 5, 8, 14, 18, and 19 are rejected under 35 USC § 103(a) as being unpatentable over Chao and Mixon in further view of US patent 5804088 (McKee). It is the applicant's understanding of the examiner's rejection that neither Chao nor Mixon forms a resist material on an inorganic antireflective or polysilicon layer, but that McKee shows a lithographic process involving such layers. The McKee reference, although discussing feature transfer to an underlying polysilicon or inorganic antireflective layer, does nothing to rectify the shortcomings of Chao and Mixon. McKee in fact, as previously discussed, specifically teaches use of a plasma isotropic etchant. McKee makes the invention all the more unobvious. Therefore, the applicants respectfully request that the rejection of the claims over Chao in view of Mixon and McKee be withdrawn.

Claims 6 and 7 are rejected under 35 USC § 103(a) as unpatentable over Chao, Mixon, McKee and in further view of US patent 6121123 (Lyons). It is applicant's understanding that Lyons adds the teaching that SiON is known as a bottom antireflective coating. Although Lyons does teach silicon oxynitride, it again does not ameliorate the shortcomings of Chao, Mixon and McKee. It is therefore respectfully requested that the rejection of claim 6 and 7 over Chao in view of Mixon, McKee and Lyons be withdrawn.

Reconsideration of the office action in view of the above amendments and remarks is respectfully requested.

Respectfully submitted,

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